Usability Testing Comparing DUAT and AWARE

Text versus context-sensitive graphics and text

Introduction

NASA recently initiated a large multi-year safety program to develop technologies that will eventually reduce aviation accidents and fatalities attributable to weather. Eight cooperative research agreements were awarded under this program. AWARE (Aviation Weather Awareness and Reporting Enhancements) is a NASA Cooperative Research and Development program conducted jointly by Rockwell Science Center, Rockwell Collins, and NASA.

AWARE is an enhanced weather briefing and reporting tool designed to integrate graphical and text-based aviation weather data to provide clear situational awareness in the context of a specific pilot, flight and equipment profile[1,Uckun]. In its third year of development, we have implemented AWARE as a web-based preflight planning tool, primarily for general aviation pilots, who do not have access to support such as dispatchers, available for commercial airlines.

Various pilots have evaluated and provided feedback for the AWARE application throughout the development phase, including contributions to the underlying decision analysis model [2, TechReport]. Recently, a formal usability task was designed and implemented with the purpose of comparing the ability of subjects (general aviation pilots) to identify all relevant weather hazards for a VFR flight based on using current text-based systems (DUAT) or using AWARE. In addition, we hoped to ascertain areas of growth for AWARE, based on the pilots' evaluations.

Methodology

Experimental design

The usability task is defined to determine the effectiveness, efficiency, and satisfaction levels of subjects using AWARE to evaluate flight plans based on specific pilot, aircraft, and location constraints. The results of the AWARE-based evaluations are compared with the results of the same subjects evaluating the same flight plans but using DUAT as the source of weather data. Currently, the graphical aspects of AWARE are designed for VFR flights, although the hazard analysis model is capable of evaluating IFR flights.

Four VFR flight plans were chosen, from areas that would be generally unfamiliar to all subjects, reducing a priori flight evaluation defaults for the areas (Texas, North Dakota, Iowa, Nebraska). The flights represent a variety of weather hazards, including levels for general winds, cross winds, visibility and ceiling. In addition, one flight includes convective activity. The flights are summarized in Table 1.

	Flight Origin/Destination	Parallel Flight	Weather Hazards for Flight Plan
A	CID-OSH (Iowa-Wisconsin)	CID-ATW	Visibility (O/D), Ceiling (O/D)
B	SNY-VTN (Nebraska)	VTN-SNY	Winds (O/D), Cross Winds (O/D)*
C	DFW-SHV (Texas-Louisiana)	DFW-DTN	Visibility(O/D),Ceiling(O), Convective activity
D	FAR-MOT (North Dakota)	ISN-5N8	Visibility(O), Ceiling(O/D), Wind(O)*

Table 1: Flight plans used for evaluations

*** invert origin/destination weather for parallel flight**

Each flight plan represents inclement weather status, easily discernable by subjects to prevent flight success. However, each flight also includes additional weather hazards. While this

provided simplicity for subjects' determination of go/no-go status for the flight, full analysis of the flight plan became more detailed.

DUATs were obtained for each of the flights. Parallel flight plans were then defined for comparison tests using AWARE, with slight change of locations; in some cases, the origin and destination were reversed, in others a nearby airport was selected. In this manner, each subject evaluated each flight plan using both DUAT and AWARE, with no recall between their previous evaluation of the flights. This was verified on completion of all tests.

For all tests, the pilot preferences were standardized at known levels to avoid variation in test results based on risk aversion variations in the pilots.

For each test, whether using DUAT or AWARE as the data source, we determined the efficiency for subjects finding all weather hazards by timing and by their subjective evaluation, and the effectiveness and subjective satisfaction levels of the subjects when using each data source. In addition, we interviewed each subject for suggested areas of growth for AWARE.

Subject selection process

To access a variety of general aviation pilots, we sent an on-line request (Appendix A) to a local flying club (West Valley Flying Club; Palo Alto, CA), indicating the purpose of the survey and asking for qualified volunteers within three classes of flight experience for evaluating our prototype compared with DUATs. This guaranteed that all subjects would be computer-capable. From the respondents, two pilots were chosen from each of the three levels of experience. Three levels of experience were sampled for determining responses from a variety of subjects, rather than for comparisons between them. Based on the experimental design, independent results were achieved by testing each pilot against all flight plans for each source of data.

A small sample group (5-10 subjects) such as this is effective for usability tests [3, Nielsen]; this size group, in evaluating initial prototypes, will identify 80-95% of the major limitations in a system. In addition, using a smaller group allows us to determine in depth the responses of the subjects.

The six pilots, summarized in Table 2, represent diversity in experience, in VFR/IFR capability, in ability to understand Metar terminology, in definition of flight-stoppers, and in specific hopes for elements of an ideal pre-flight weather planner.

Each pilot completed an initial questionnaire (Appendix B), from which the following table is extracted.

Pilot	**Experience**	**Metar translation capability** (scale 1-10, 1 low, 10 high)	**Flight Stoppers** (origin/destn; en route)	**Ideal System**	**AWARE addresses**
1	Commercial, IFR, 1400 hours	10	Ceil/Vis; Ceil/Vis/Cloud layers/Tstorms/Icing	Current/forecast along route; temp & clouds aloft; radar / lightning.	All except icing, cloud layer & lightning
2	Private, IFR, 1300 hours	1	Ceil/Vis; Icing/Tstorms	Icing, thunderstorms; current conditions @O/D; fuel comp'n	All except icing
3	Private, IFR, 450 hours	10	Ceil/Vis/Winds; Icing/Turb/Convec'n	Single website access; graphical representation of flight	All except icing, turbulence, cloud tops.

				path and weather. Accurate (better than TAF) forecasts; Cloud Tops, Winds, Icing, Turbulence	
4	Private, 470 hours (recently flying after 15 year hiatus)	6	Ceil/Vis; Wind/Ceil	Zoomable surface charts available for past 12 hours; current conditions at O/D and alternates; live WebCams along route.	All except "zooming" on graphics, and WebCams along route
5	Private,160 hours	8	Ceil/Vis; Cloud/Wind/Precip /Tstorm/Icing	Graphical current/ projected wx. Highlight known contraindications; ceiling/vis duration of flight. Trend animation, wind shear.	All except trend animation (for contraindications) and wind shear
6	Private, 85 hours	9.5	Vis/Ceil; Winds/Tstorm	Ground conditions O/D, enroute winds & precip	All desired ideals.

Table 2: Summary of Pilot expertise

Facilities and Materials

The usability task was administered one-on-one with all subjects coming to our laboratory, each on two different days. Introductions to the project and to the usability task took place in a private office where the AWARE testing would occur. The DUAT portion of the task was conducted in a conference room, allowing sectionals to be fully viewed. The AWARE portion was completed in an office with the AWARE system running from a Netscape web browser on a standard PC system.

For each test, the subjects were asked to fully evaluate the complete flight under VFR constraints, rather than stopping at an initial go/no-go decision. They were unobtrusively timed during each evaluation, but were not limited in the time allowed.

On the first visit, the subjects evaluated flights A and B using DUAT, and C and D using AWARE. On the second visit, approximately one week later, the sources for the tests were reversed, with subjects evaluating flights A and B using AWARE and C and D using DUAT.

During the DUAT evaluation of flight paths, we provided the subjects the full DUATs listing (including natural language and forecasts) as extracted for the flight from GTE FSD. In addition, we gave them the sectionals representing the specific flight path; since they were unfamiliar with the locales, we annotated the sectionals to indicate Origin/Destination, and a subset of the weather reporting stations for the flight. We also had available the AOPA airport directory, and a ruler for determining distance. While no graphical AIRMET/SIGMET summaries were provided, they were available had any of the pilots requested them. For each flight test, the pilots had an evaluation form to complete (Appendix C).

For the AWARE evaluation of flight paths, the pilots were logged into the demonstration system at www.awin.org/aware, and asked to evaluate the flight using the web-based graphical presentation specific to the four pre-selected aircraft, pilot, and flight paths.

Procedure, Data Collection

Task phases

Introduction: During the first visit, the subjects were introduced to the AWARE system using a power point slide-show; this slideshow was designed, at the request of NASA, for use in the Oshkosh NASA Safety tent [4, Oshkosh Demo]; it is available on our web site. It explains the benefits and goals of AWARE: "It is designed to benefit general aviation pilots who, due to cognitive overload, may not absorb and retain all flight-critical weather information from the vast (cryptic) stream of data they are legally required to review…"; "…integrating text-based and graphical weather data for superior situational awareness *in the context of a* ***specific*** *mission and equipment profile."* It then steps through the options within AWARE

- viewing weather at airport locations, or
- evaluating weather for a specific flight for a pilot with known preferences (for ceiling, visibility, fuel reserves, winds and cross-winds), and a specific aircraft.

It is the second function that the subjects are evaluating, and the slideshow then progresses through the definition of preferences for the pilot, and details for the aircraft. In both cases, default values are defined and may be modified by the pilot. The slideshow displays an existing flight plan, and the evaluation of that flight plan is shown in a graphical manner, given the weather in the area for that time period. AWARE graphical displays are shown, including animation of Nexrad images, forecasting storm progressions, overlays of specific weather elements such as wind, pressure, and weather phenomena (icons indicating various types of precipitation, smoke and ash). The availability of raw Metar/FA/Winds Aloft/TAF and SIGMET text data is demonstrated. Finally, the formal Hazard Analysis is displayed in a graphical form, organized by phase of flight (takeoff, enroute, landing), including the existence of any known hazards and optionally the basis for determining why they are hazards (preferences, actual weather reports, airport runway limitations). Subjects asked questions throughout the presentation.

To verify their understanding of the AWARE system, we then demonstrated evaluations of two flight plans using AWARE itself, and urged the subjects to interact with the flight plan briefing portion of the application. All demonstrations were constrained to VFR.

We included in the introduction identifications of

- the goals of the usability test ("acts as comparison for effectiveness of Aware/Duats"),
- the types of tasks ("All flights have easily discernible weather that will allow you to reject the flight easily, but we want your determination of the details of entire flight.") and
- the limits of aware ("At this point, we are not accessing data which we could parse and graphically visualize for turbulence, icing, thunderstorm severity"; "we are also not including turbulence or icing in the hazard analysis; thunderstorms at origin/destination are evaluated for proximity but not for severity in the hazard analysis. We do, however, graphically indicate the existence of thunderstorms with Nexrad animations and icon overlays"; "AWARE is currently VFR specific for graphical displays.").

Initial Questionnaire: As mentioned in the subject selection section above, the pilots all completed an initial questionnaire (Appendix B). The purpose was to determine their varying levels of flight experience, their current use of various sources of weather data, their ability to translate Metars, and their definition of an "ideal graphical system" for portraying weather in a pre-flight briefing.

Table 2 summarizes that information, with the exception of current weather sources. In general, they all used DUAT either from GTE or DynCorp, and each of them then augmented DUAT with

web-based data sources. These sources included WxTAP, graphical AIRMET/SIGMET data from adds, NOAA and FAA data including surface charts. They all expressed an interest in having access to a website that could consolidate all of this data for them; AWARE is designed to serve that purpose.

First Visit, DUAT evaluation of flights: The subject was then given flight plan A to evaluate using DUAT, including the DUAT listing, the sectionals and supporting materials described in the Facilities and Materials section above. We noted start times, and when the subject completed his written evaluation of the entire flight, noted the stop time. The sectionals and supporting materials were removed, and the procedure was repeated for flight plan B.

The forms used are shown in appendix C. It should be noted that for all tests, the pilot preferences were predefined at known levels to avoid variation in test results based on variations in risk aversion in the pilots.

First Visit, AWARE evaluation of flights: The subject was seated at the monitor showing the AWARE evaluation of flight plan C, based on the same pilot preferences and aircraft assumptions given for the DUAT evaluation of flights. We reviewed with the subject how to interact with the summary graphical display, the hazard analysis and the animation, and gave them the evaluation form. Again, the start and stop times were noted. On completion, we initiated the display for flight plan D, and the procedure was repeated.

For both flights C and D, the subject was urged to explore the use of AWARE; this provided us valuable feedback on the overall use of the system, often giving immediate suggestions for better methods of presentation. However, it was difficult to perform accurate timing as the users explored and asked questions about AWARE, and the times reported for completion of the task using AWARE often include all of the time spent exploring and discussing the system.

Approximately one week later, the subjects each returned, and evaluated the same four flight plans under modified airport names. In discussions with the subjects after completion of all tests, none of them had recognized that they had evaluated only four flight plans, twice each.

Second visit, DUATs evaluation of flights: Using the same procedure as described for the first week, the subject then evaluated flight plans C and D using DUAT, filling out the required evaluation form for each.

Second visit, AWARE evaluation of flights: Using the same procedure as described for the first week, the subject then evaluated flight plans A and B using DUAT, filling out the required evaluation form for each.

IFR interviews: If the pilot was IFR rated, we spent time discussing our plans for modifying the existing graphics to provide enhanced IFR displays. The underlying decision analysis model of AWARE already supports the ability to analyze IFR flights.

Closing Questionnaire: On completion of all flight evaluations, the pilots all completed a closing questionnaire (Appendix D). The purpose was to determine their response (criticisms as well as positive feedback) to AWARE in general, and to rank the value of specific functional elements of AWARE. The summary of these questionnaires is included in the Results section below.

The pilots were then given a gift certificate for use at an on-line flight shop, in appreciation for their time and feedback.

Example Flight

The flight from DFW-DTN (alternately DFW-SHV, with DTN and SHV being two airports in Shreveport, LA) includes hazards of ceiling(O), visibility(O/D), and thunderstorms in the general area of the flight. A small subset of the DUAT for that flight is shown Figure 1; the entire document is 39 pages long. Figure 2 shows a small subset of the sectional for the flight, focusing at Shreveport, LA, and including the annotations for destination (green) and weather sources.

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********  FA Synopsis and VFR Clouds/Weather  ********
DFWC FA 081045
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 090500
CLDS/WX VALID UNTIL 082300...OTLK VALID 082300-090500
OK TX AR TN LA MS AL AND CSTL WTRS
.
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HGTS DENOTED BY AGL OR CIG.
.
SYNOPSIS...AT 11Z CDFNT DXO-BNA-JAN BECMG QSTNRY JAN-BRO LN.
WRMFNT LOZ-GQO-ATL LN. BY 05Z LOW PRES NERN LA WITH CDFNT MLU-
LCH-60S BRO LN AND WRMFNT MLU-LOU-DXO LN. TROF ELD-TUL LN. DSIPTG
QSTNRY FNT APE-VXV-ATL LN. HIGH PRES SWRN TX. ...DARRAH...
.
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.
.
KNFW 081855Z 33011KT 4SM BR SCT009 OVC015 06/04 A2985 RMK
     SLP107 T2 SET T00600040
KNFW 081905Z 33015KT 3SM BR BKN009 OVC015 06/04 A2985 RMK
     SLP107 T2 SET
METAR KFTW 081853Z 33011KT 7SM OVC012 05/04 A2983 RMK AO2 SLP104
    T00500039
SPECI KFTW 081908Z 33011KT 7SM FEW008 OVC016 05/04 A2984 RMK AO2
SPECI KFTW 081921Z 32013KT 5SM BR BKN008 OVC016 05/04 A2983 RMK AO2
    CIG 006V011
METAR KAFW 081853Z 35012KT 5SM BR OVC011 06/04 A2986 RMK AO2 PRESFR
    SLP115 T00560044
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Figure 1: A subset of DUAT for the example flight

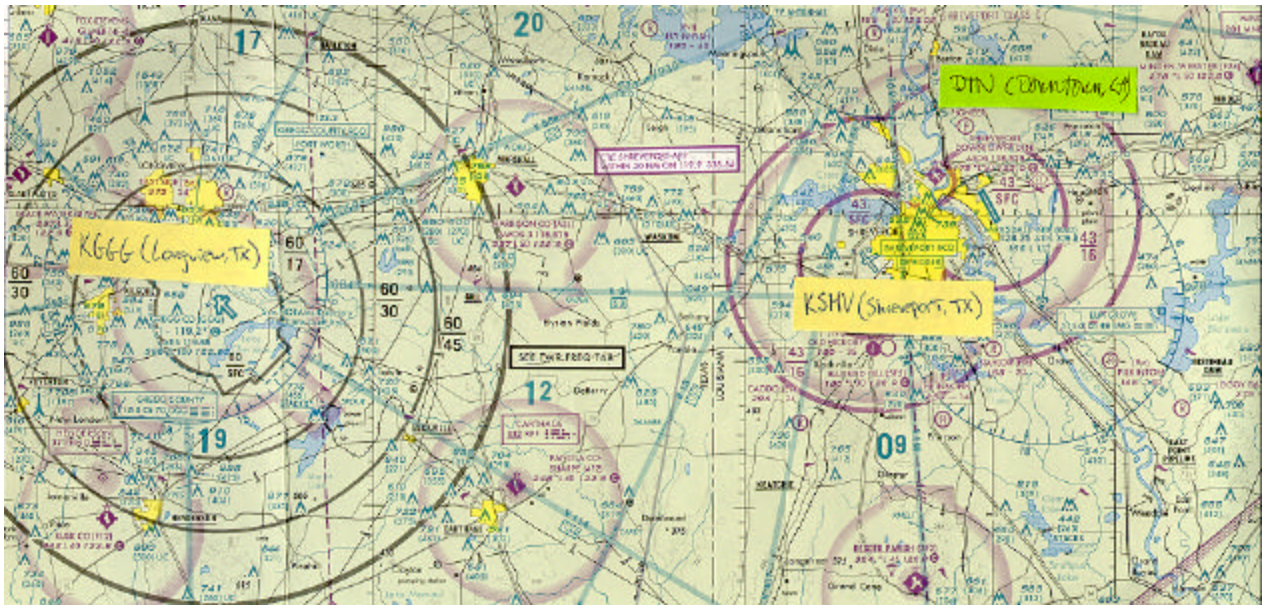

Figure 2: A subset of the sectional near the destination airport, with annotations for destination (KDTN) and other weather sources (KGGG, KSHV). It measures approximately 12” x 6”; all sectionals for this flight measure approx 36” x 12”.

Based on the data represented by the two samples in Figure 1 and Figure 2, the subjects performed the DUAT portion of the test, evaluating the weather with respect to the flight plan, and completed the evaluation form.

For the same flight plan for the AWARE portion of the test, the initial and expanded hazard analysis displays for weather hazards for the flight plan are shown in Figure 3.

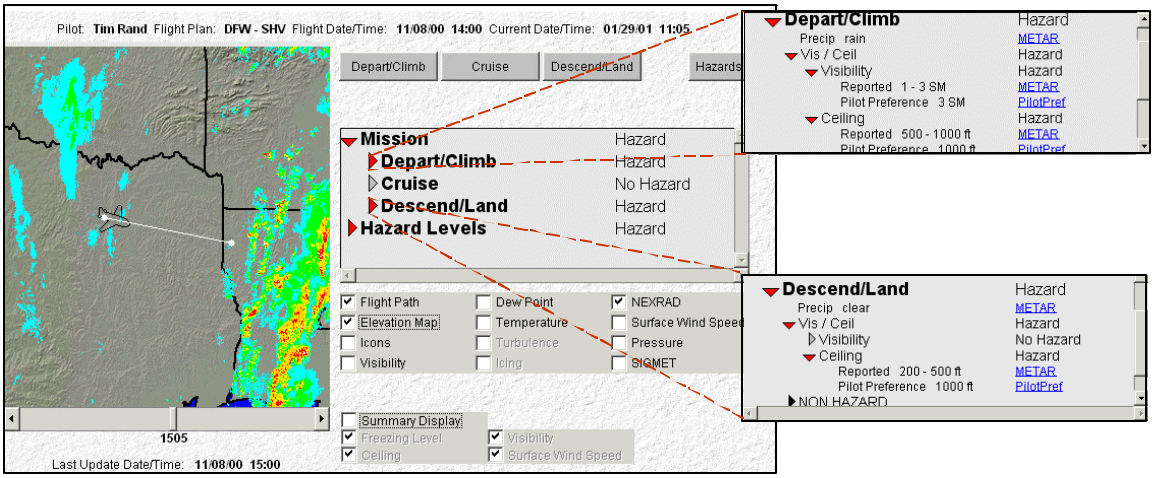

Figure 3: Example flight results using AWARE

The blue textual elements are links that allow the pilot to review the source data, whether Metar, TAFS, FA, Sigmets, or pilot preferences/aircraft details. The AWARE display also has options to display overlays for multiple elements (Wx Phenomena Icons, Wind, ...), as indicated in Figure 4.

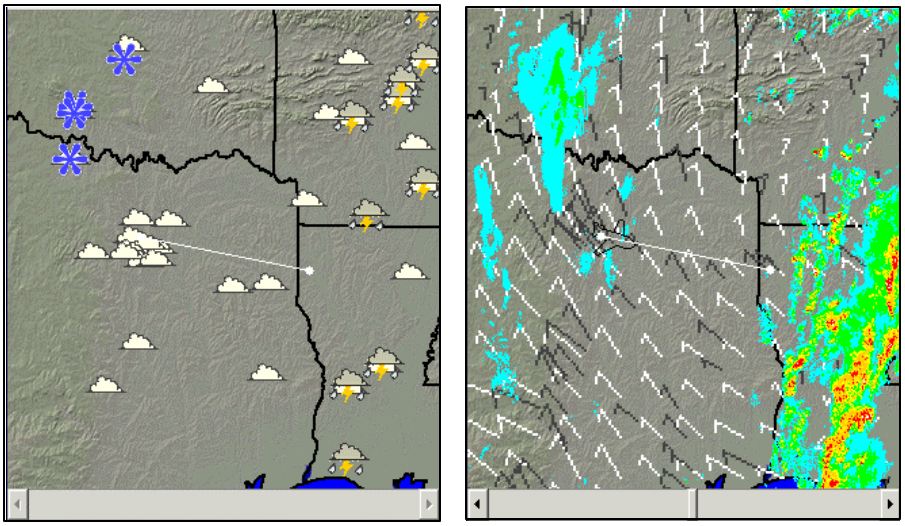

Figure 4: Overlays for Weather phenomena (Snow, Clouds, Thunderstorms) (left), and for winds (right)

The Summary Display allows the user to check for go/no-go conditions graphically, for ceiling, visibility, freezing levels, and surface winds, as shown in Figure 5. In this case, the subject chose to first display the visibility, then the ceiling, then the combined Summary Display of ceiling/visibility.

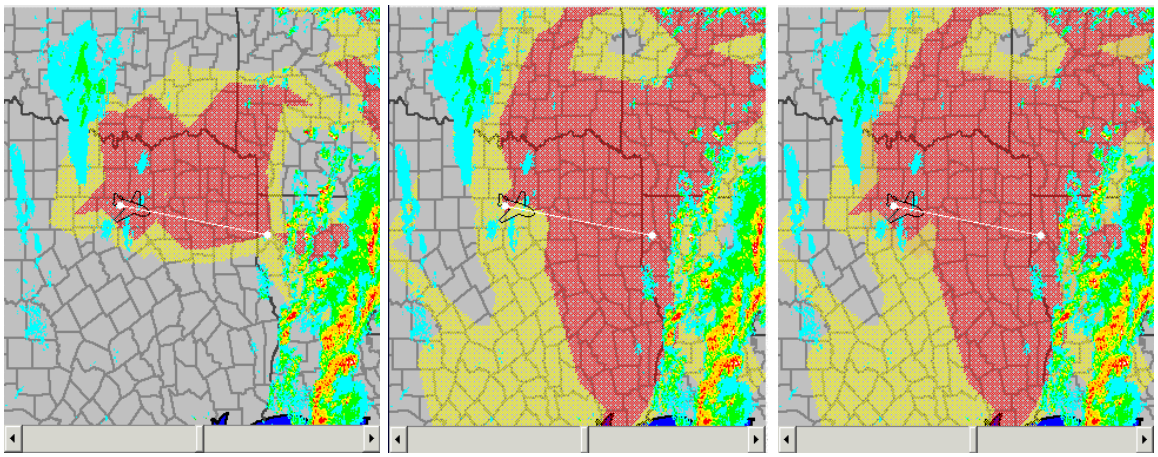

Figure 5: Visibility hazard display, Ceiling hazard display, Summary Ceil/Vis hazard display; yellow indicates caution, red indicates hazard, based on preferences.

By manipulating the displays, either by expanding hazard analysis elements or varying summary display options, the subjects determined the flight hazards for the flight.

Vertical profiles are also available, limited to displaying winds aloft and ceiling parameters. A more interesting example, including terrain variations and high winds approaching mountains is shown for this flight, with smaller wind barbs representing surface winds, larger wind barbs representing winds aloft at varying levels, and gray towards the left representing the level of ceiling (blue is below ceiling level).

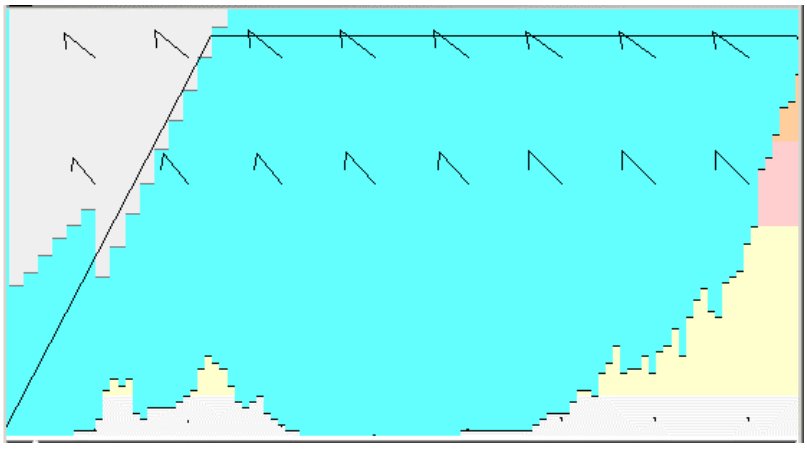

Figure 6: Vertical profile of flight plan, indicating terrain, surface winds, winds aloft, and ceiling data

Results

Four issues were evaluated in the analysis: efficiency, effectiveness, and satisfaction of using AWARE and using DUAT, and subjective ratings for the functional elements of AWARE. Simple statistical analysis was performed on data acquired both by timing and from evaluation forms.

Quantitative

Objective Efficiency: Each subject was unobtrusively timed during the completion of both DUAT and AWARE tasks. Figure 7 shows the overall objective results, indicating that for each user, the average time required to complete the tasks was at least 40% less using AWARE (subject 1) and as much as 5 times faster (subject 6). It should be noted that the timing measurements for the DUAT portion of the task were accurate; however, the timing measurement for the AWARE portion often included exploration time and/or discussion of additional options. Hence, the performance for AWARE efficiency is even better than indicated in the chart.

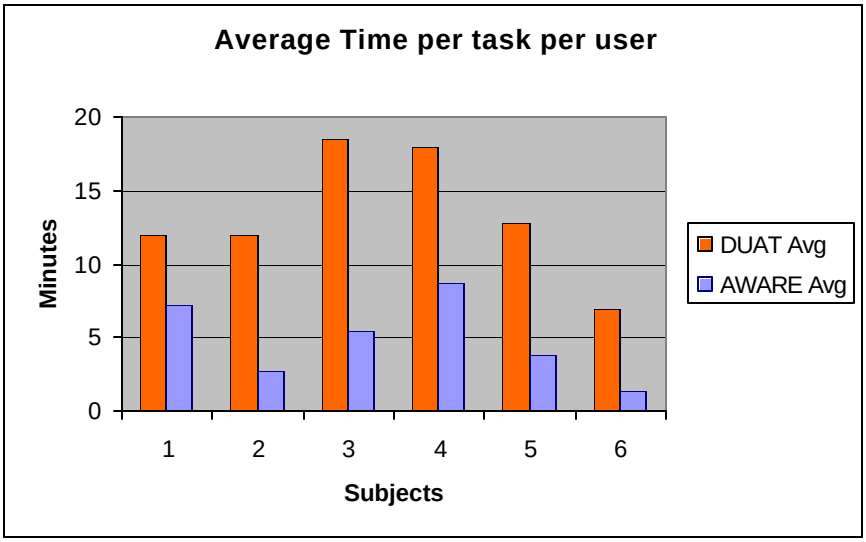

Figure 7: Average Time to complete each task per user

There was considerable variation across each user for the four tests. In one case, one subject took 8 times as long to complete one flight evaluation using DUAT.

Objective Effectiveness: From the forms filled out for each test, the effectiveness of finding all hazards within a flight was summarized, and is shown in Table 3. There were no false findings using either of the systems; that is, no subjects erroneously reported non-existent weather hazards.

Flight	A	B	C	D
AWARE	5 of 6 subjects found all hazards, 1 found 50%	1 found all, 3 found 75%, 1 found 50%	1 found all, 5 found 75% (all but thunderstorms).	3 found all, 2 found 75%, 1 found 50%
DUAT	2 of 6 subjects found all hazards, 4 found 50%	1 found all, 6 found 50%.	2 found all, 3 found 75%, 1 found 50%	3 found all, 1 found 75%, 2 found 50%

Table 3: Measured effectiveness of AWARE vs DUAT

In general, AWARE supported the subjects finding more complex details, especially winds, ceiling, visibility and crosswinds at all phases of the flights. AWARE users, however, did not generally note thunderstorm activity. This is disappointing but not unexpected, since at this point, there was no hazard analysis of thunderstorm data; the only AWARE presentation of thunderstorm activity involved the graphical Nexrad data, animations and icon overlays.

Subjective Effectiveness, Efficiency, and Satisfaction: Based on the forms completed for each test, the subjective evaluations for effectiveness (functionality), efficiency (speed), and satisfaction were calculated, and are shown in Figure 8. Again, AWARE was rated as more efficient, more effective, and more satisfying.

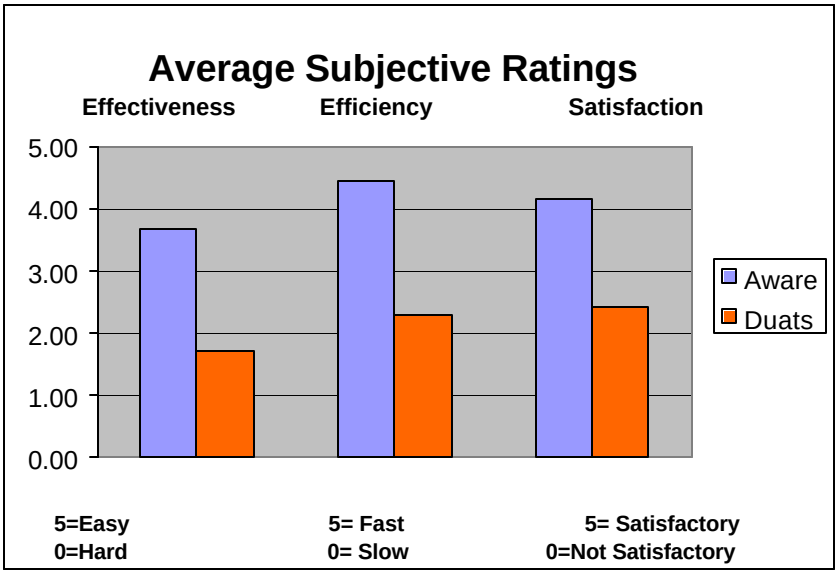

Figure 8: Subjective evaluations for functionality, speed, and satisfaction

In the closing questionnaire, subjects were asked to rate the various AWARE features. Figure 9 shows the results, with green indicating highly preferred features. The subjects found highest value in the Context Sensitivity, Nexrad data and animations, Storm tracking (projections), the Summary hazard display and the Hazard Analysis features.

Figure 10 indicates the standard deviation over the feature preference results, in the same order as shown in Figure 9. The main variation between subjects on the rating of the features occurred in their value for the availability of raw source data, whether for phase of flight display of Metars/FA/TAF data or for the basis of the hazard analysis; some found them to be compelling, others found them unnecessary. In subsequent discussions, there was also variance on the preference for raw Metar listings or plain text translations; some users preferred the integrity of the raw data, while others preferred the simplicity of the plain text. There was also variation in value for the display of dew-point and temperature overlays; while they agreed there is value in these parameters IF COMBINED to determine the delta, the presentation of them as separate entities was considered ineffectual.

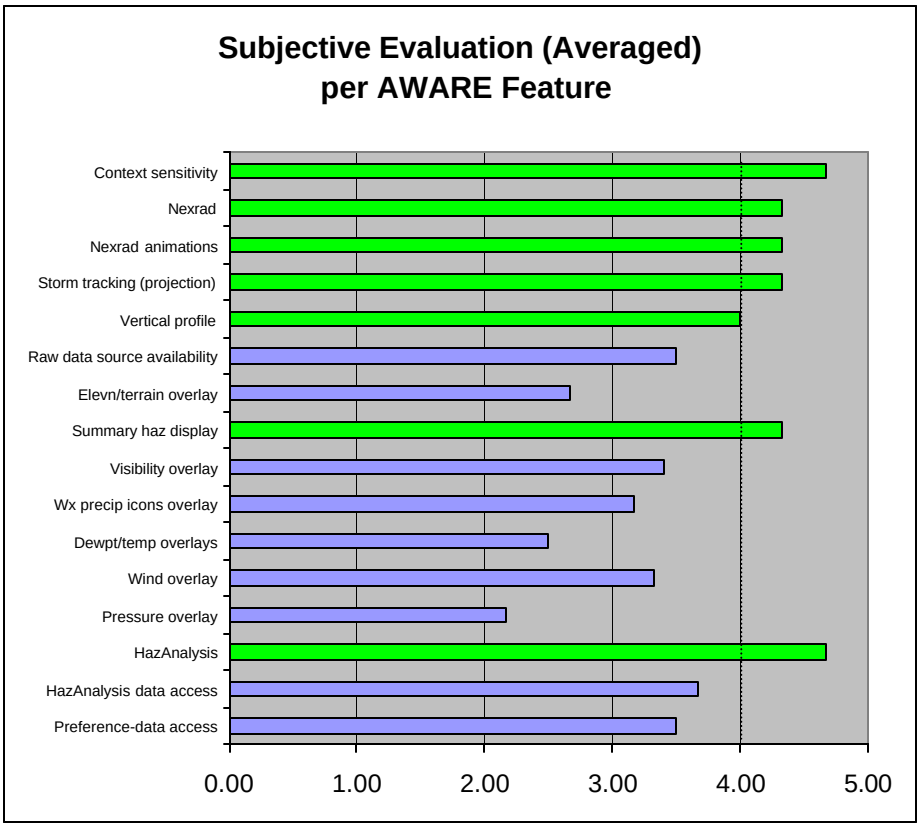

Figure 9: Subject evaluation of AWARE features; indicates high preference

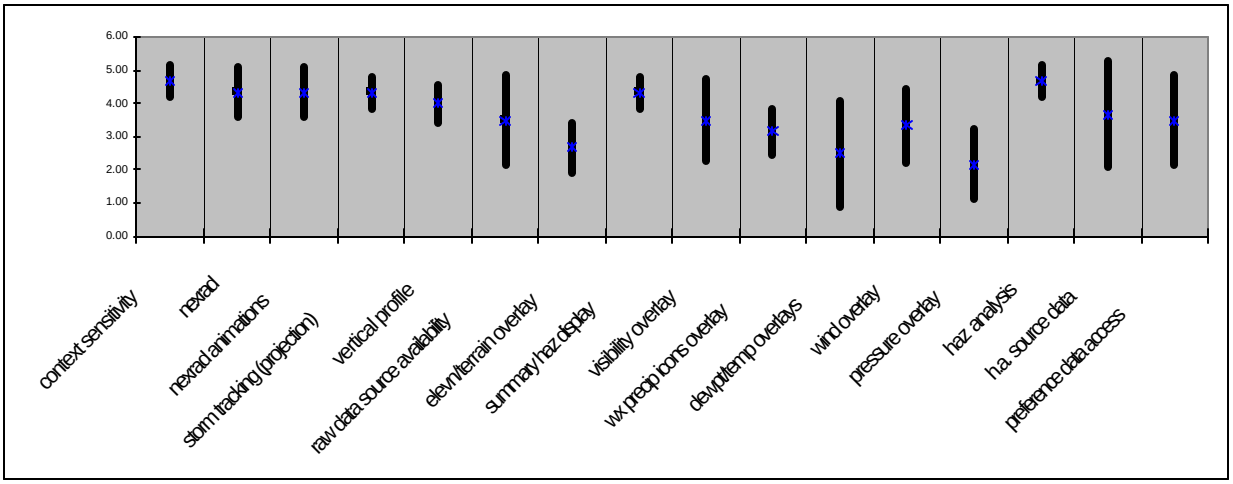

Figure 10: Variation in ratings of AWARE features

Qualitative

In addition to the quantitative measures discussed above, subjects indicated the strengths and limitations of AWARE in their closing questionnaire, as shown in Table 4

	AWARE Strengths	AWARE Limitations
1	"Can I have it now?"	-
2	Hazard analysis	Thunderstorm/icing data
3	Hazard analysis, graphical feedback	Ceiling/visibility enroute; pireps & Notams
4	Hazard analysis, Summary display	Pireps, better vertical profile, zooming; quantifiers for graphics
5	"All of it"	Plain text format for raw data
6	Hazard analysis, Nexrad	Vertical profile of icing; quantifiers for graphics

Table 4: Qualitative feedback on current AWARE strengths & limitations

Conclusions

The objective of this study was to determine the effectiveness, efficiency, and satisfaction levels of subjects using AWARE to evaluate VFR flight plans based on specific pilot, aircraft, and location constraints. As shown in the Results section above, AWARE provides a more effective (functional), more efficient (speed) and more satisfactory experience than the use of DUATs.

The subjects unanimously want access to AWARE, even in its current prototype form. Their closing forms included responses to the question "If AWARE were made available, would you use it?" of "Absolutely!" and "Can I have it now??". While subjects were given a small monetary incentive, it was clear that their interest was more in using AWARE and in being able to have an impact on its future direction.

In general, AWARE supported the subjects finding more complex details, especially winds, ceiling, visibility and crosswinds and runway details at all phases of the flights. The limitations in the effectiveness of AWARE are related to the current release level; at this time, we are not including data for icing, turbulence, nor hazard analysis for thunderstorms. We DO include additional calculations such as endurance (based on headwinds along route), crosswind for the "best" runway, and quick determination of the impact of changing preferences.

The failure of the subjects to recognize thunderstorm proximity using AWARE was disheartening, since graphical representations (animation and weather phenomena icons) clearly indicated thunderstorm activity in the area. We theorize that the subjects became dependent on the Hazard Analysis, and reported their results primarily from that basis. Another theory is that, in this case (as was often the case in DUATs), they simply reported the most obvious VFR hazards.

The subjects found the features Context Sensitivity, Nexrad data and animations, Storm tracking (projections), the Summary hazard display and the Hazard Analysis to be of highest value. Since one of the unique efforts of this project was the underlying decision analysis model that provides the hazard analysis and the context sensitivity, this was edifying. Our work in visualization also contributes to the Summary hazard display.

As an additional outcome, subjects were entirely independent for perusing AWARE to determine the flight hazards on the second day of testing. Although this was not a test of the usability of AWARE, it was clear that this would not be a major issue.

Future work

We are expanding our access to additional data sources, including Icing and Turbulence. While we are currently parsing Convective Sigmets, our visualization effort is incomplete, and we are trying to gain access to additional Sigmets and Airmets data, for parsing and visualization.

In addition, we will be enhancing the vertical profile display to include icing and thunderstorm data. We are also incorporating more IFR-relevant displays for the planar flight route view, including summary ceiling / visibility indicators for all reporting stations within a 200-mile corridor of the flight plan. IFR mode is already incorporated into the hazard analysis model. Dew point/temperature displays will be combined into one hazard display. We hope to provide more quantifying information using mouse-over, especially for wind, Sigmet, and summary display data.

In fiscal years '01 and '02, AWARE is being expanded to provide support for commercial airlines, as well as having a subset of AWARE ported to in-cockpit use.

References

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[3] J. NIELSEN, **DESIGNING WEB USABILITY,** NEWRIDERS PUBLISHING, INDIANAPOLIS, INDIANA

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Appendix A: Subject (Pilot) Request

To www.wfvc.org

Subject: volunteers needed to evaluate GA pre-flight weather displays

In cooperation with NASA, Rockwell has designed a pre-flight weather briefing system, primarily for General Aviation pilots. We need feedback on our prototype from pilots that would be using this system; volunteers for this evaluation will receive $100 gift certificates to Sporty's Pilot Shop.

We are conducting a comparison test, evaluating the effectiveness of our graphical system in comparison with the use of DUAT and other commercial aviation weather reports. We need participation by volunteers in 3 levels of experience:

- < 100 hours flying (e.g., student pilots who have recently soloed & passed written exams)
- >50 hours flying cross-country
- >500 hours flying cross-country.

The evaluations will occur primarily during the month of December, will require interactions on 2 separate days of about 2-3 hours each, and will take place at the offices of Rockwell Science Center in downtown Palo Alto.

Appendix B: Pilot Profile: Opening Questionnaire

Name:_____pilot name_____ Phone:_____

1) How many years have you been a pilot? _____

2) What is your level of pilot certification

   Recreational Private Commercial Airline Transport

3) What is your (approximate) total number of flight hours: _____

4) Are you an instrument rated pilot? Yes No
   If so, are you current to fly instruments: Yes No

5) What types of airplanes have you flown in the last year?

6) Computer experience -
   a. How long have you been using computers? _____
   b. How frequently do you use a computer? (circle one)

      All day Once/day Once/week Once/month Less frequently

   c. How frequently do you use the web (WWW)? (circle one)

      All day Once/day Once/week Once/month Less frequently

7) What sources do you use for aviation weather before a flight (check all that apply):

   For PreFlight?

   _____ DUAT _____ PilotBrief _____ ADDS _____Other specify:

   _____ FAA Weather Briefer (800.Wx.Brief) _____ Graphical Airmets/Sigmets

   For InFlight? (specify)

8) Are you familiar with the following symbols from aviation weather reports? If so, define each you know.

   RA _____
   BR _____
   FG _____
   SN _____
   FZ _____

GR _____
TS _____
RVR_____

9) If you can, please translate the following METAR weather report:

KSFO 291554Z 26012G18KT 10SM SCT040 BKN100 15/05 A2985

10) What type of weather information do you look for when flight planning?

11) What kinds of weather do you avoid? How do you avoid it?

12) What kind of weather would cancel a flight?

13) What weather types do you evaluate before taking a flight, in order of go/no-go

14) What is your idea of the perfect set of weather information; list anything (whether currently available) that would be valuable to you.

Appendix C: AWARE/DUAT Usability Test

Pilot Name _____pilot name_____

Flight identification ___ Korg -Kdst ____ General Location: _stae __

Source of weather data: Aware or DUAT

Aircraft Burn rate & Fuel amount: 6 gallons/hour, 53 gallons

Given pilot preferences of

- **>3sm visibility**
- **<25 knots winds**
- **<10 knots cross winds**
- **>30 minutes fuel reserve**
- **>1000 feet ceiling**

Would you take this flight, based on the weather information you were given representing the time period?
Yes No

If not, what is the most critical weather indication, based on the above preferences?
(Identify limitation as well as when it occurred, i.e. during which phase of the flight …. Departure, Cruise, Land)

Are there any other weather hazards for this flight, based on these preferences? (What, when)

How effective is it to find this information in the media you are using?

Hard 1 2 3 4 5 *Easy*

How fast is it to find this information in the media you are using?

Slow 1 2 3 4 5 *Fast*

How satisfactory is it to find this information in the media you are using?

Not 1 2 3 4 5 *Satisfactory*

Appendix D: Pilot Profile: Closing Questionnaire

Name:_____pilot name_____Phone:_____

1) Do you always access some weather source prior to a flight? Yes No

2) Currently, what sources?

3) If AWARE were available, would you use it? Yes No

4) If not, what are the limiting factors to AWARE's functionality?

5) Rate each of the following capabilities of AWARE, for its value to you, where 1 is low and 5 is high

   a. Context sensitive analysis _____ 1 2 3 4 5
   b. Nexrad _____ 1 2 3 4 5
   c. Nexrad animations _____ 1 2 3 4 5
   d. Projected tracking of storms _____ 1 2 3 4 5
   e. Vertical profile _____ 1 2 3 4 5
   f. Availability of raw metar/fa/sigmet/airmet data _____ 1 2 3 4 5
   g. Elevation / terrain overlay _____ 1 2 3 4 5
   h. Summary display of visibility / winds / ceiling / freezing _ 1 2 3 4 5
   i. Overlay display of visibility _____ 1 2 3 4 5
   j. Overlay display of weather icons _____ 1 2 3 4 5
   k. Overlay display of Dewpoint / Temperature _____ 1 2 3 4 5
   l. Overlay display of winds _____ 1 2 3 4 5
   m. Overlay display of pressure _____ 1 2 3 4 5
   n. Hazard analysis _____ 1 2 3 4 5
   o. Access to source of data used in hazard analysis _____ 1 2 3 4 5
   p. Access to context sensitive data used in hazard analysis _ 1 2 3 4 5

6) What are the specific things you disliked, not mentioned above?

(over)

7) What is your confidence in your ability to correctly assess the weather without AWARE?

8) What is your confidence in your ability to correctly assess the weather with AWARE when it includes turbulence, thunderstorm, and more icing analysis?

9) Are there any parts of AWARE that you'd like to have available immediately?

10) What would you be willing to pay/month for use of AWARE when it is completely functional?

11) How do you find the quality of existing phone-based weather briefers?

12) If AWARE were to be made available as a web-connection at WestValley Flying Club, what changes/additions should be made? Before it's made available?

13) One direction that this project may take is toward incorporation of AWARE in the cockpit. Do you find value in that concept? Yes No

    Details?

14) Are you willing to take part in subsequent User Evaluations of AWARE, as more features are released? Yes No